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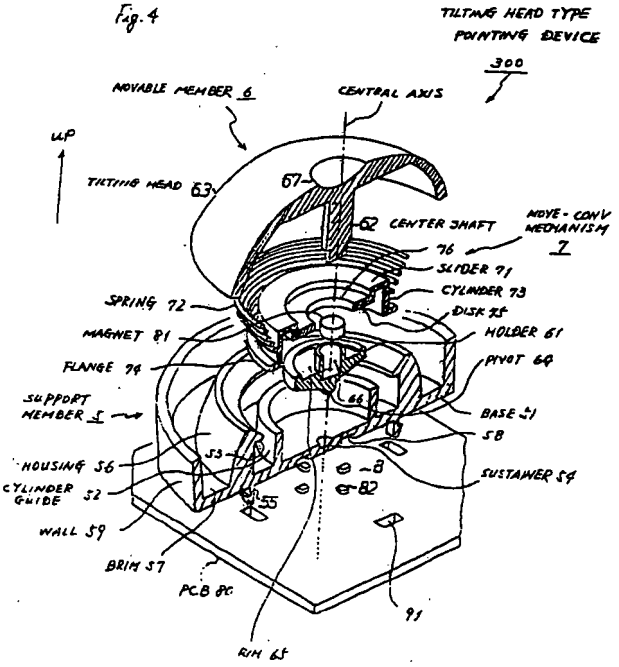
(54) Pointing device for moving and positioning a pointer on a display of a computer

(57) A pointing device for moving a display pointer by tilting a center shaft including a magnet and using Hall elements fixed near the magnet. The center shaft is sustained by a pivot sustainer fixed on a central axis of the device, and the tilting movement of the center shaft is changed to movement made along the central axis by a movement converting mechanism using spring force, for moving the magnet back on the central axis when the center shaft is freed from tilting.



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a pointing device for moving a pointer or a cursor on a display of a computer to a desired position. In particular, the present invention relates to a pointing device which produces no positioning error of the pointer even though mechanical vibration or shock is added to the pointing device after determining a designated position of the pointer, so that the pointer is moved back to the designated position after the vibration or shock is over.

Generally, data for operating a computer or carrying out application programs of the computer are processed by operating a keyboard of the computer. Recently, a pointing device such as a mouse or a digitizer comes into existence and its usefulness has been widely approved because of convenience of performing dialog operation between an operator and the computer.

The pointing device, which will be called a separated type pointing device hereinafter, such as the mouse or the digitizer is usually applied to a desk-type computer. However, when a portable computer such as a laptop type or a notebook type computer comes into existence, the separated type pointing device becomes inconvenient of use. Because, it is hard to find a space for placing the separated type pointing device around the portable computer.

Then, a new type pointing device, which will be called an attached type pointing device hereinafter, such as a track-ball type, a tilting lever (or joystick) type or a sliding head type pointing device has been developed for the portable computer.

The attached type pointing device is mechanically attached to the keyboard, not requiring a space for operating the attached type pointing device around the portable computer. The attached type pointing device is also applied to an amusement computer generally called "game machine". In case of the amusement computer, a terminal box is usually used for remotely controlling the amusement computer. The attached type pointing device is mounted on the terminal box so that the attached type pointing device can be easily handled by anyone from a child to a man in any posture, sitting on a sofa or lying on a floor. The attached type pointing device consists of a supporting member and a manually actuating movable member, which will be simply called "movable member" hereinafter, mounted on the supporting member. The supporting member is for supporting the movable member and fixing the attached type pointing device to the keyboard or the terminal box. The movable member is provided for moving the pointer on the display by touching the movable member with a finger of the operator. The movable member can be moved freely in a limited zone. When the movable member is freed from the operator's touch, the movable member returns to a center position of the limited zone and stays there, and when the movable member is moved, the pointer is moved on the display in the same direction as the movable member at a speed proportional to a distance of the movable member moved from the center position.

In either case of the portable computer or the amusement computer, when the movable member is freed from operator's touch after the pointer has been positioned to a designated position on the display, it is desired that the pointer is fixed to the designated position and not affected by vibration or shock added to the pointing device and/or a change of a supporting posture of the pointing device against gravity.

In short, the attached type pointing device has been required to have a high returning accuracy, producing no pointing error when the vibration or shock is added to the pointing device and/or the supporting posture of the pointing device is changed.

Typical pointing devices of the prior art are shown in Figs. 1, 2, 3A, 3B and 3C. Fig. 1 is a schematic side view of a joystick type pointing device (100) of the prior art, Fig. 2 is a schematic side view of a sliding head type pointing device (200) of the prior art, and Figs. 3A, 3B and 3C illustrate typical returning mechanisms of the prior art, applied to the movable member of the sliding head type pointing device 200 shown in Fig. 2.

The joystick type pointing device 100 shown in Fig. 1 is a typical attached type pointing device of the prior art applied to the amusement computer. The joystick type pointing device 100 consists of a lever (marked LEVER in the figure) (11), a close-coiled helical spring (SPRING) (13) inserted between a root of the LEVER 11 and a frame (FRAME) (12) the LEVER 11 is mounted on, and a pointer coordinate detecting part (DET PART) (14) consisting of a light emitter (LIGHT EMITTER) provided at a bottom tip of the LEVER 11 and a light receiver (LIGHT REC) (16) arranged on a printed circuit board (PCB) (17) located beneath the FRAME 12 directly opposite to the LIGHT EMITTER 15. The LIGHT REC 16 consists of a plurality of light detecting elements arranged in a matrix. For example, a Charge-Coupled Device (CCD) is used for the LIGHT REC 16. When the LEVER 11 is leaned against the force of the SPRING 13, the shaft of the LEVER 11 inclines, so that a direction of light radiated from the LIGHT EMITTER 15 is changed. Then, the light radiated from the LIGHT EMITTER 15 comes into designated light detecting elements. As a result, the designated light detecting elements produce electrical signals having information on a direction and a moving speed of the pointer.

However, when the joystick type pointing device is applied to the terminal box, there have been problems as follows.

1) Because of that the joystick type pointing device cannot be made small in size, the size of the terminal box becomes large. As a result, the terminal box

must be held by both hands, causing a problem that the terminal box is hard to be held by children.

2) When the LEVER 11 is freed from the operator's hand, a gravity center of the LEVER 11 is moved upward because of the characteristics of the SPRING 13. Therefore, there is a problem that when a supporting posture of the terminal equipment is changed, the LEVER 11 tends to incline due to terrestrial gravitation and vibrate due to a mechanical shock given to the terminal box.

3) When the LEVER 11 having inclined is freed from the operator's hold, the LEVER 11 is going to return to a center position by the force of the SPRING 13. However, because of the characteristics of the SPRING 13, the LEVER 11 does not completely return to the center position, particularly when the inclination of the LEVER 11 is little. This produces a problem of decreasing the returning accuracy of the pointer, so that the pointer does not stays the designated position and drifts inch by inch.

In order to solve the above problems, a new attached type pointing device called "sliding head type pointing device" has been developed. Regarding the sliding head type pointing device, Japanese Patent Publication 7-117876 and United States Patent 5,504,502 are given to the same inventor Takashi Arita and others in Dec. 18, 1995 and Apr. 2, 1996 respectably.

Fig. 2 is a cross-sectional side view of the sliding head type pointing device 200 of the prior art. The sliding head type pointing device 200 consists of a sliding head (SLIDING HEAD) (21) as the movable member and a housing (HOUSING) (22) as the supporting member.

The SLIDING HEAD 21 has a round domed configuration consisting of a domed rubber part (RUBBER) (23) and a domed slider (SLIDER) (24) provided on an inner surface of the RUBBER 23. At a center of the RUBBER 23, there is an inward depressed portion into which a finger tip is inserted for sliding the SLIDING HEAD 21 on the HOUSING 22. At the inward depressed portion, there is a magnet holding part (25) in which a permanent magnet (MAGNET) (26) is buried so as to be placed at the center of the SLIDING HEAD 21. The SLIDING HEAD 21 is set on the HOUSING 22 so that the MAGNET 26 is brought in a central axis of the HOUSING 22 when the SLIDING HEAD 21 is freed. The MAGNET 26 is used for producing information on a position and moving speed of the pointer on the display. In order to produce the information, other kinds of elements such as optical elements may be used. Therefore, an element such as the MAGNET 26 can be called "pointer positioning element" generally.

The HOUSING 22 has round domed structure for mounting the SLIDING HEAD 21 and fitting the sliding head type pointing device 200 to the terminal box not depicted in Fig. 2. An upper surface of the HOUSING 22 is formed to a domed configuration so as to contact with the domed slider 24 of the SLIDING HEAD 21. The HOUSING 22 has an aperture at the center thereof for allowing the magnet holding part 25 passing through. In the HOUSING 22, a printed circuit board 28 is provided for wiring magnetically reluctant elements 27 and an electric switch 29.

At least two magnetically reluctant elements 27 are arranged on the printed circuit board 28, separated at equal distance from the central axis of the HOUSING 22 respectively. The magnetically reluctant elements 27 pick up a magnetic field of the MAGNET 26 respectively, producing electric signals regarding the position and moving speed of the pointer on the display. When the SLIDING HEAD 21 is slid, the magnetically reluctant elements 27 pick up the magnetic field respectively and produce electric signals in response to the slid direction and the slid amount of the SLIDING HEAD 21 from the central axis of the HOUSING 23. The electric signals from the magnetically reluctant elements 27 are processed for producing signals of the moving direction and speed of the pointer on the display. Namely, the moving direction and speed of the pointer are designated by the slid direction and distance of the SLIDING HEAD 21 from the central axis of the HOUSING 22 respectively. The magnetically reluctant elements 27 are for detecting the position and moving speed of the pointer on the display. Therefore, the magnetically reluctant elements 27 can be called "pointer co-ordinate position detectors" generally.

The electric switch 29 is mounted on the PCB 28 so as to be on the central axis of the HOUSING 22 for making perform a click operation of the sliding head type pointing device 200. When the depressed portion of the RUBBER 23 is pushed down, the electric switch 29 is pushed so that the electric switch 29 performs the click operation.

Not depicted in Fig. 2, the sliding head type pointing device 200 has a mechanism for returning the SLIDING HEAD 21 to the center position when the SLIDING HEAD 21 is freed from the operator's finger. The mechanism will be called "returning mechanism" hereinafter. Figs. 3A, 3B and 3C show several types of the returning mechanisms in the sliding head type pointing device 200 of the prior art. In Fig. 3A, a garter belt spring (GARTER-BELT SPRING) (33) having configuration of a garter belt is hooked alternatively among a plurality of ("four" in Fig. 3A) poles (31 and 32) provided inside the SLIDING HEAD 21 and on the HOUSING 22 respectively. By virtue of tensile strength of the GARTER BELT SPRING 33, the SLIDING HEAD 21 intends to returns to the center position of the HOUSING 22 when the SLIDING HEAD 21 is freed. In Fig. 3B, instead of the GARTER BELT SPRING 33 in Fig. 3A, a plurality of ("four" in Fig. 3B) straight springs (STRAIGHT SPRINGs) (36) having the same tensile strength each other are respectively hooked between hooks 31 and 32 neighbored to each other. By virtue of the tensile strength of the STRAIGHT SPRINGs 36, the SLIDING HEAD 21 intends to return to the center position when

the SLIDING HEAD 21 is freed. In Fig. 3C, in order to couple the SLIDING HEAD 21 with the HOUSING 22, a coil-forced spring (COIL SPRING) (35) is provided between the SLIDING HEAD 21 and a spring holder (34) provided to the HOUSING 22 along the central axis of the HOUSING 22. By virtue of the restoring force of the COIL SPRING 35, the SLIDING HEAD 21 intends to return to the center position when the SLIDING HEAD 21 is freed.

Thus, when the SLIDING HEAD 21 is freed, the SLIDING HEAD 21 intends to return to the center position on the central axis of the HOUSING 22 by the returning mechanism. However, in either case of Fig. 3A, 3B or 3C, since the spring is laid between the SLIDING HEAD 21 and the HOUSING 22, the SLIDING HEAD 21 is returned to the center position only by the restoring force of the spring. Therefore, if the restoring force of the spring is strengthened, the SLIDING HEAD 21 becomes hard to be handled, and if the restoring force of the spring is weakened, the SLIDING HEAD 21 becomes hard to be returned. In particular, when the SLIDING HEAD 21 is slid a small amount, the SLIDING HEAD 21 is hard to be returned to the center position. Since the sliding head type pointing device has been a representative attached type pointing device, it can be concluded that the returning accuracy of the attached type pointing device has been low in the prior art.

As described in reference with Fig. 2, the moving direction and speed of the pointer on the display can be changed in any value in an analog fashion. Namely, the MAGNET 26 and the magnetically reluctant elements 27 formulate analog pointing system in compliance with analog pointing software. However, there is other pointing system called digital pointing system operating under digital pointing software. The digital pointing system is required for, for example, a high speed game. In case of the digital pointing system, the pointer moves on the display digitally a predetermined distance every step, in a predetermined direction such as up, down, right, left or diagonal direction of those. Therefore, in the digital pointing system, only a switching function is enough to move the pointer. As a result, in order to operate both the analog pointing system and the digital pointing system with one terminal box, another pointing device called "switching type pointing device" is required to be added to the terminal box for the digital pointing system. This causes troubles that the terminal box becomes complex in operation and large in size.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to increase the returning accuracy of the attached type pointing device.

Another object of the present invention is to improve the returning mechanism so that the movable member never move by reason of the vibration or the shock added to the attached type pointing device freed from the finger's touch or the change of the posture of the attached type pointing device against gravity.

Another object of the present invention is to make the size and weight of the attached type pointing device small and light respectively so that the attached type pointing device can be mounted to a small box such as the terminal box of the amusement computer and the attached type pointing device can be handled easily.

Another object of the present invention is to make the attached type pointing device operate in compliance with both analog and digital pointing software.

Still another object of the present invention is to simplify a structure of the attached type pointing device, for increasing the operational reliability and decreasing the manufacturing cost.

The above objects are accomplished by improving the returning mechanism of the attached type pointing device. The invented attached type pointing device consists of a manually actuating movable member, a supporting member and a movement converting mechanism placed between the movable member and the supporting member.

In the above constitution of the invented attached type pointing device, firstly, a very important feature is that the invented attached type pointing device has a central axis established at the supporting member, and secondly, there are two different points from the sliding head type pointing device of the prior art, one is that the movable member has a center shaft sustained by a sustainer provided at the supporting member so as to be on the central axis and the other is that the movement converting mechanism is newly provided as the returning mechanism, for obtaining very high returning accuracy of the movable member.

By virtue of providing the center shaft, when the movable member is moved by the operator's finger, the center shaft can be tilted about the pivot sustainer.

By virtue of providing the movement converting mechanism, transversely tilting movement of the center shaft of the movable member is converted to longitudinally cylindrical sliding movement made along the central axis. Wherein, the cylindrical sliding movement is always forced toward the supporting member by a helical spring provided to the cylindrical sliding mechanism. When the movable member is freed from the operator's finger after the pointer has been moved, by virtue of converting the transversely tilting movement to the longitudinally sliding movement and appropriately adjusting the force of the helical spring, the center shaft of the movable member is securely returned to a former position on the central axis. Namely, by virtue of adopting the center shaft and the movement converting mechanism to the tilting head type pointing device, the high returning accuracy can be realized.

When the invented attached type pointing device works under the analog pointing system, similarly to the sliding head type pointing device, a magnet is buried in the center shaft of the movable member as the pointer positioning element and magnetically reluctant elements are set on the printed circuit board, namely near

by the magnet, as the pointer co-ordinate position detectors. The magnet is positioned on the central axis when the movable member is freed. The magnetically reluctant elements are arranged so as to be separated at equal distance from the central axis. The magnetically reluctant elements pick up a magnetic field of the magnet respectively and produce electric signals regarding the pointer position and the moving speed of the pointer on the display.

When the invented attached type pointing device works under the digital pointing system, it is only required that the movable member is used for turning switches ON. That is, it is not necessary to use the pointer positioning element and the magnetically reluctant elements, it is only required to use the movement converting mechanism for obtaining the high returning accuracy of the center shaft and to make switches ON-OFF under the digital pointing system.

Considering the above, a moving mechanism is added to the invented attached type pointing device so as to be fixed to the bottom of the pointing device, for moving the switches up and down. When the attached type pointing device operates under the analog pointing system, the switches are lowered so as no to be operated , and when the pointing device operates under the digital pointing system, the switches are raised so as to be operated. By virtue of mechanically adding the moving mechanism to the invented attached type pointing device, the invented attached type pointing device can be operated under both analog and digital pointing system.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic side view of the joystick type pointing device 100 of the prior art;

Fig. 2 is a schematic side view of the sliding head type pointing device (200) of the prior art;

Fig. 3A is a schematic figure for illustrating a returning mechanism using a garter-belt spring;

Fig. 3B is a schematic figure for illustrating a returning mechanism using four straight springs;

Fig. 3C is a schematic figure for illustrating a returning mechanism using a coil spring;

Fig. 4 is a partially cross-sectional and dismantled perspective view of the tilting head type pointing device 300, for illustrating a preferred first embodiment of the present invention;

Fig. 5 is a sectional side elevation view of the tilting head type pointing device of the first embodiment, for illustrating the operation of the movable member freed from the operator's finger;

Fig. 6 is a sectional side elevation view of the tilting head type pointing device of the first embodiment, for illustrating the operation of the movable member tilted by the operator's finger;

Fig. 7 is a partially cross-sectional and dismantled perspective view of a tilting head type pointing device, for illustrating a preferred second embodiment of the present invention;

Fig. 8 is a sectional side elevation view of the tilting head type pointing device of the second embodiment, for illustrating operation of a moving mechanism and a switching unit for the second embodiment in case where the pointing device of the second embodiment operates under the digital pointing system and the movable member is freed from touching;

Fig. 9 is a sectional side elevation view of the tilting head type pointing device of the second embodiment, for illustrating the operation of the moving mechanism and the switching unit for the second embodiment in case where the pointing device of the second embodiment operates under the analog pointing system and the movable member is freed from touching; and

Fig. 10 is a sectional side elevation view of a modified tilting head type pointing device of the second embodiment, for illustrating the operation of a modified moving mechanism and switching unit for the second embodiment in case where the pointing device of the second embodiment operates under digital pointing system and the movable member is freed from touching.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the attached type pointing device of the present invention in case where the pointing device operates under the analog pointing system is shown in Figs. 4, 5 and 6 as a first embodiment, and another preferred embodiment of the attached type pointing device of the present invention in case where the pointing device operates under either the analog or the digital pointing system is shown in Figs. 7, 8, 9 and 10 as a second embodiment. Throughout Figs. 4 to 10, the same reference numeral designates the same part or unit.

Fig. 4 is a partially cross-sectional and dismantled perspective view of the invented attached type pointing device for the first embodiment, Fig. 5 is a sectional side elevation view in case where a movable member of the invented pointing device is freed from the operator's finger, and Fig. 6 is a sectional side elevation view in case where the movable member is moved by the operator's finger. The movable member of the invented pointing device has a head which can be manually tilted. For this reason, the invented attached type pointing device will be called "tilting head type pointing device" hereinafter. In Figs. 4, 5 and 6, the mechanism of the tilting head type pointing device will be described but the analog pointing system itself is omitted to be detailed because of the prior art.

Fig. 7 is a partially cross-sectional and dismantled perspective view of the invented attached type pointing device of the second embodiment, Fig. 8 is a sectional side elevation view of the attached type pointing device of the second embodiment in case where the pointing

device operates under the digital pointing system, and Fig. 9 is the same but in case where the pointing device operates under the analog pointing system. In reference to Figs. 7, 8 and 9, the moving mechanism and the switching unit will be described but the digital pointing system itself is omitted to be detailed because of the prior art.

By the way, in order to describe the structure and function of the pointing device, a word such as "up", "upward", "down", "downward", "top" or "bottom" will be used in compliance with an arrow marked "UP" depicted respectively in all figures in this specification.

As shown in Fig. 4, a tilting head type pointing device (300) consists of a manually actuating movable member (MOVABLE MEMBER) (6), a supporting member (SUPPORT MEMBER) (5), and movement converting mechanism (MOVE-CONVERT MECHANISM) (7). The MOVABLE MEMBER 6 is for manually moving and pointing the pointer on the display by the operator's finger. The SUPPORTING MEMBER 5 is for supporting the MOVABLE MEMBER 6 and the MOVE-CONVERT MECHANISM 7 on the basis of a central axis (CENTRAL AXIS) of the SUPPORTING MEMBER 5 and mounting the tilting head type pointing device 300 to a printed circuit board (PCB) (80). The MOVE-CONVERT MECHANISM 7 is for converting the tilt motion of the MOVABLE MEMBER 6 to the longitudinal sliding motion made in the direction of the CENTRAL AXIS.

The MOVABLE MEMBER 6 consists of a center shaft (CENTER SHAFT) (62), a tilting head (TILTING HEAD) (63) connected with the CENTER SHAFT 62, a permanent magnet (MAGNET) (81), and a magnet holder (HOLDER) (61) connected to the CENTER SHAFT 62 with the MAGNET 81.

The TILTING HEAD 63 is shaped like a dome or turn over cap having an inward depressed portion (67) at a center thereof. The CENTER SHAFT 62 can be tilted by the operator's finger touching the depressed portion 67. The HOLDER 61 has a sleeve at the center thereof, in which the CENTER SHAFT 62 is inserted with the MAGNET 81. The MAGNET 81 is provided as the pointer positioning element which is described in reference with Fig. 2. The HOLDER 61 has a pivot (PIVOT) (64) having a half-spherical tip at the bottom and center of the HOLDER 61. The PIVOT 64 is firmly set in a pivot sustainer (SUSTAINER) (54) provided at the center of the SUPPORT MEMBER 5, on the CENTRAL AXIS. By virtue of the PIVOT 64 and the SUSTAINER 54, the CENTER SHAFT 62 can be tilted omnidirectionally in a direction, which will be called "tilt direction" hereinafter, around the CENTRAL AXIS and at an angle, which will be called "tilt angle" hereinafter, from the CENTRAL AXIS. The HOLDER 61 has another function relating to the MOVE-CONVERT MECHANISM 7. The HOLDER 61 has a round rim (RIM) (65) looking upward, at an edge of a round brim spread from the CENTER SHAFT 62. When the CENTER SHAFT 62 is tilted, the RIM 65 pushes up the MOVE-CONVERT MECHANISM 7 which results in converting the tilt motion of the MOVABLE MEMBER 6 to the longitudinal sliding motion.

The MOVE-CONVERT MECHANISM 7 consists of a slider (SLIDER) (71) and a spiral spring (SPRING) (72). The SLIDER 71 consists of a cylinder (CYLINDER) (73), a hole (76) made at the center of the SLIDER 71 for passing the CENTER SHAFT 62 therethrough even when the CENTER SHAFT 62 of the MOVABLE MEMBER 6 is tilted about the SUSTAINER 54, a disk part (DISK) (75) spread between the hole 76 and the CYLINDER 73 so that the lower surface of the DISK 75 is always contacted with the RIM 65 of the HOLDER 61 by the downward force of the SPRING 72, and a round flange (FLANGE) (74) stretched out from the CYLINDER 73 at the bottom of the CYLINDER 73 for stopping the SPRING 72. The action of the downward force of the SPRING 72 will be explained later in reference with Figs. 5 and 6.

The SUPPORT MEMBER 5 mainly consists of a round base (BASE) (51), a round cylinder guide (CYLINDER GUIDE) (52) and a round housing (HOUSING) (56). The CYLINDER GUIDE 52 and the HOUSING 56 are stood on the BASE 51 in the same direction as the CENTRAL AXIS. The BASE 51 is for mounting the tilting head type pointing device 300 on the PCB 80, on the basic of the CENTRAL AXIS. AT the BASE 51, the SUSTAINER 54 is provided at a center of the BASE 51 so as to be on the CENTRAL AXIS, four hooks (HOOKS) (55) are provided for fixing the BASE 51 to the PCB 80, a brim (BRIM) (57) is expanded at the periphery of the BASE 51 so as to be used as a tilt stopper of the TILTING HEAD 63, and four hollows (58) are provided on a bottom surface for allowing four magnetically reluctant elements (82) to mount on the PCB 80. The CYLINDER GUIDE 52 is stood on the BASE 51 for guiding the CYLINDER 73 of the MOVE-CONVERT MECHANISM 7. The HOUSING 56 is for housing the MOVE-CONVERT MECHANISM 7. The upper surface of the HOUSING 56 is slanted downward and inward and a hook (53) is provided under the slanted surface, for installing and fixing the MOVE-CONVERT MECHANISM 7 in the HOUSING 56, which will be fully explained later.

On the PCB 80, four magnetically reluctant elements 82 are mounted as the pointer co-ordinate position detectors (8) similarly to the magnetically reluctant elements 27 of the sliding head type pointing device 200 shown in Fig. 2, and four holes (91) are provided for hooking the hooks 55 so that the center of the BASE 51 coincides with arrangement center of the magnetically reluctant elements 82. The magnetically reluctant elements 82 are arranged on the PCB 80 so as to be separated respectively with equal distance from the center of the BASE 51 fixed to the PCB 80. Similarly to the sliding head type pointing device 200 shown in Fig. 2, the magnetically reluctant elements 82 produce the electric signal of the co-ordinate position of the pointer and the moving speed of the pointer on the display, in cooperation with a position of the MAGNET 81 buried in the HOLDER 61.

The MOVABLE MEMBER 6, the MOVE-CONVERT MECHANISM 7 and the SUPPORT MEMBER 5 are assemble to the tilting head type pointing device 300 in accordance with the following numbered steps:

(1) the HOLDER 61 is assembled by putting the MAGNET 81 in the hole 66;
(2) the HOLDER 61 including the MAGNET 81 is inserted into the SUPPORTING MEMBER 5 so that the PIVOT 64 is set in the SUSTAINER 54;
(3) the MOVE-CONVERT MECHANISM 7 is partially assembled by putting the SPRING 72 on the CYLINDER 73;
(4) the partially assembled MOVE-CONVERT MECHANISM 7 is put into the SUPPORT MEMBER 5 by sliding the CYLINDER 73 into the GUIDE 52 of the SUPPORT MEMBER 5 and putting the SPRING 72 between
the hook 53 of the HOUSING 56 and the FLANGE 74 of the SLIDER 71 against the spread force of the SPRING 72, so that the HOLDER 61 sustained by the SUSTAINER 54 through the PIVOT 64 is kept down by the SPRING 72;
(5) the tilting head type pointing device 300 is discretely assembled by pushing the CENTER SHAFT 62 of the MOVABLE MEMBER 6 into the hole 62 of the HOLDER 61 with the MAGNET 81; and
(6) the discretely assembled tilting head type pointing device 300 is mounted on the PCB 80 by inserting the HOOKS 55 of the SUPPORT MEMBER 5 into the holes 91 of the PCB 80 on which the magnetically reluctant elements 82 and other circuits associated with the magnetically reluctant elements 82 are previously set on and printed.

The tilting head pointing devices 300 mounted on the PCB 80 are illustrated in Figs. 5 and 6 in cross-sectional views. Fig. 5 illustrates a case where the MOVABLE MEMBER 6 is not tilted because of no operator's finger-touch to the TILTING HEAD 63. That is, the MOVABLE MEMBER 6 stands by itself by virtue of the extension force of the SPRING 72. Fig. 6 illustrates a case where the MOVABLE MEMBER 6 is tilted because of operator's finger-touch to the TILTING HEAD 63.

In Fig. 5, because of no operator's touch to the TILTING HEAD 63, the CENTER SHAFT 62 of the TILTING HEAD 63 is freed. Therefore, by virtue of the expanding force of the SPRING 72 fitted between the hook 53 of the HOUSING 56 and the FLANGE 74 of the SLIDE 71, the DISK 75 of the SLIDER 7 pushes the RIM 65 of the HOLDER 61 down in the direction of the CENTRAL AXIS of the SUPPORT MEMBER 5. As a result, the CENTER SHAFT 62 stands in the direction of the CENTRAL AXIS perpendicularly to a bottom surface of the BASE 51 of the SUPPORT MEMBER 5. Since the SPRING 72 always pushes all around the RIM 65 through the DISK 75, when the weight of the MOVABLE MEMBER 6 is lightened and the expanding force of the SPRING 72 is selected properly, it can be avoided occurring that the MOVABLE MEMBER 6 vibrates due to the shock or the mechanical vibration added to the tilting head type pointing device 300 and the CENTER SHAFT 62 inclines from the CENTRAL AXIS of the SUPPORT MEMBER 5 due to the posture of the tilting head type pointing device 300 against the gravity.

In Fig. 6, when the MOVABLE MEMBER 6 is moved, the CENTER SHAFT 62 is tilted about the SUSTAINER 54 in a tilt direction (on the right in Fig. 6). Then, the RIM 65 pushes the DISK 75 (accordingly the SLIDER 71) up in the direction of the CENTRAL AXIS of the SUPPORT MEMBER 5 against the extending force of the SPRING 72. Namely, when the CENTER SHAFT 62 inclines about the SUSTAINER 54, the RIM 65 pushes the SLIDER 71 through the DISK 75. However, since the SLIDER 71 is restricted to move only in the direction of the CENTRAL AXIS by the CYLINDER 73 sliding on the GUIDE 52 of the SUPPORT MEMBER 5, the tilt movement of the MOVABLE MEMBER 6 is converted to the movement in the direction of the CENTRAL AXIS of the SUPPORT MEMBER 5. When the TILTING HEAD 63 is freed from the operator's touch, the CENTER SHAFT 62 is brought back to the position of the CENTRAL AXIS as shown in Fig. 5.

When the MOVABLE MEMBER 6 is moved, the MAGNET 81 stored in the CENTER SHAFT 62 changes its spatial position, and the changed position of the MAGNET 81 is detected by the magnetically reluctant elements 82 mounted on the PCB 80. Namely, the tilt direction and angle of the CENTER SHAFT 62 are detected by the magnetically reluctant elements 82. The magnetically reluctant elements 82 produce electric signals from which the moving direction and speed of the pointer on the display are determined. These are the same as the relation between the MAGNET 26 and the magnetically reluctant elements 27 in the sliding head type pointing device 200 described in reference with Fig. 2. The tilt angle of the TILTING HEAD 63 is mechanically limited when the TILTING HEAD 63 hits the BRIM 57 of the BASE 51.

The second embodiment of the present invention is prepared by modifying the attached type pointing device of the first embodiment described as the tilting head type pointing device 300 in reference with Figs. 4 to 6. The modification is performed by adding a moving mechanism and a switching unit to the tilting head type pointing device 300. The moving mechanism is for changing system from analog to digital system and vice versa by manually operating a lever on the moving mechanism. When the lever is turned to an analog mode, the switching unit is mechanically and functionally disconnected from the tilting head type pointing device 300, so that the tilting head type pointing device of the second embodiment operates the same as the tilting head type pointing device 300. When the lever is turned to a digital mode, the switching unit is connected with the TILTING HEAD 63 of the tilting head type pointing device 300, so that the pointing device of the second embodiment operates as a switching device, however

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keeping the returning mechanism of the tilting head type pointing device 300 using.

Fig. 7 is a partially cross-sectional and dismantled perspective view of a moving mechanism (MOVING MECHANISM) (9) and a switching unit (SWITCH UNIT) (10) of a tilting head type pointing device (400), for illustrating the second embodiment of the present invention.

As shown in Fig. 7, the tilting head type pointing device 400 is constructed by adding the MOVING MECHANISM 9 and the SWITCH UNIT 10 to the tilting head type pointing device 300 shown in Fig. 4. Namely, the MOVING MECHANISM 9 is provided under the PCB 80 and the SWITCH UNIT 10 is provided between the PCB 80 and the MOVING MECHANISM 9. In Fig. 7, it is omitted to depict the details of the tilting head type pointing device 300.

The MOVING MECHANISM 9 consists of a stator (STATOR) (91) fixed to a lower surface of the PCB 80 and a rotor (ROTOR) (92) turned around the STATOR 91. The STATOR 91 consists of a post (93) fixed to the PCB 80 and a plurality of, four in Fig. 7, fixed cams (FIXED CAMs) (94) arranged around a base of the post 93. The ROTOR 92 has a center hole 95 through which the ROTOR 92 is fitted to the post 93 so that the ROTOR 92 can be turned around the post 93.

The ROTOR 92 consists of a rotary lever (LEVER) (96) projected from the ROTOR 92, a round ditch (97) provided to an upper face of the ROTOR 92 for sustaining the SWITCHING UNIT 10, and a plurality of, four in Fig. 7, rotating cams (ROTATING CAMs)(98) provided to a lower face of the ROTOR 92 so as to be contacted with the FIXED CAMs 94 respectively when the ROTOR 92 is turned. The ROTOR 92 is pushed to the STATOR 91 by a spring (SPRING) (99), which is not depicted in Fig. 7 but in Figs. 8 to 10, provided between the PCB 80 and the ROTOR 92. By virtue of the SPRING 99, the ROTOR 92 can be raised up or lowered down by moving the LEVER 96 because of the combination works of the ROTATING CAMs 98 and the FIXED CAMs 94.

The SWITCH UNIT 10 consists of a ring board (101) fitted into the ditch 97 and plurality of, four in Fig. 7, switching elements (SWITCHes) (102) each having a domed actuator (103) made of, for example, rubber and a short electrode (104) fixed to the actuator 103. The SWITCHes 102 mounted on the ring board 101 are arranged in compliance with the pointing software used in the digital pointing system. A pole 105 is stood on each SWITCH 102 and a pair of electrodes (106) are provided in each SWITCH 102 so that the electrodes 106 are shorted by the short electrode 104 when the pole 105 pushes the
actuator 103. The switching performed by the SWITCH 102 will be described in reference with Figs. 8 and 9.

Figs. 8 and 9 are sectional side elevation views of the tilting head type pointing device 400, Fig. 8 is for illustrating the pointing device 400 operating under the digital pointing system and Fig. 9 is for illustrating the pointing device 400 operating under the analog pointing system, in case where the TILTING HEAD 63 is free from the operator's touch, respectively.

In Figs. 8 and 9, holes (56 and 83) are provided to the BASE 51 of the SUPPORT MEMBER 5 and the PCB 80 respectively, corresponding to the poles 105. When the ROTOR 92 is raised up by turning the LEVER 96 to the digital mode, the poles 105 are raised up so that each pole 105 can be pushed by the edge of the TILTING HEAD 63 when the TILTING HEAD 63 is tilted.

Therefore, when the TILTING HEAD 63 is tilted, the domed actuator 103 is pushed down by a pole 105. As a result, the domed actuator 103 informs crick shock to the operator's finger and the electrodes 106 are shorted, namely the SWITCH 102 is turned ON. This means that the tilting head type pointing device 400 operates only under the digital pointing system, keeping the high returning accuracy.

When the ROTOR 92 is brought down by turning the LEVER 96 to the analog mode, the poles 105 are sunk from the upper surface of the BASE 51, so that the SWITCHes 103 are not operated by the poles 105 even though the TILTING HEAD 63 is tilted. In this situation, the poles 105 are never pushed down by the edge of the TILTING HEAD 63, because the edge of the TILTING HEAD 63 is stopped at the upper surface of the BRIM 57 of the BASE 51 (see Fig. 4). This means that the tilting head type pointing device 400 operates only under the analog pointing system the same as the tilting head type pointing device 300 described in reference with Figs. 4 to 6.

Fig. 10 is a sectional side elevation view of a tilting head type pointing device 400' which is also the second embodiment of the present invention. However, the pointing device 400' is made by modifying the tilting head type pointing device 400 so that the poles 105 are merely raised or brought down, not rotated with the rotating ROTOR 92, every time the LEVER (115) is turned to the analog mode or the digital mode. Namely, the modification is performed by changing the MOVING MECHANISM 9 of the tilting head type pointing device 400 to a MOVING MECHANISM (90) shown in Fig. 10.

In Fig. 10, the same as the MOVING MECHANISM 9, the MOVING MECHANISM 90 is fitted to the lower surface of the PCB 80 together with the SWITCH UNIT 10. The MOVING MECHANISM 90 consists of a fitting part (111) for fitting the MOVING MECHANISM 90 to the PCB 80 so that a central axis of the fitting part is coincided with the CENTRAL AXIS of the SUPPOTING MEMBER 5, a ROTOR (112) and a STATOR (113). Hereupon, usage of the rotor and the stator in Fig. 10 is reversed to that in Fig. 7. The STATOR 113 is set on the fitting part 111 so as to be slid on a cylindrical outer surface of the fitting part 111 and sustained by the ROTOR 112. The ROTOR 112 is set on the fitting part 111 by inserting a boss 114 of the ROTOR 112 into the fitting part 111 and screwing the ROTOR 112 to a center shaft of the fitting part 111 so that the ROTOR 112 can be rotated around the center shaft and on an inside cylindrical surface of the fitting part 111. The ROTOR 112 has a LEVER (115) projected from the ROTOR 112

proper, formed like an "L" letter and a plurality of ROTATING CAMs 116 are provided around the boss 114. The STATOR 113 has a hole (118) at a center thereof, through which the STATOR 113 is passed and the STATOR 113 has a projection (119) protruded inward the hole 118 is provided. In order to insert the projection 119, a straight ditch (117) is provided on the outside cylindrical surface of the fitting part 111 in a direction parallel with the central axis of the fitting part 111. By virtue of inserting the projection 119 into the ditch 118, the STATOR 113 can be slid up and down on the surface of the fitting part 111 without rotation. A spring (SPRING) 99 is provided between the PCB 80 and the STATOR 113 for pushing the STATOR 113 to the ROTOR 112. By virtue of extending force of the SPRING 99, when the LEVER 115 is turned to the analog mode, the STATOR 113 is slid down, and when the LEVER 115 is turned to the digital mode, the STATOR 113 is slid up, without play between the STATOT 113 and the ROTOR 112. Different from the tilting head type pointing device 400, in the tilting head type pointing device 400', the poles 105 of the SWITCH UNIT 10 simply moves up and down, making the up-down movement of the poles 105 smooth.

Claims

1. A pointing device for moving a pointer on a display, said pointing device comprising:

   a supporting member for supporting and mounting the pointing device on an object of mounting the pointing device, said supporting member comprising a sustainer positioned on a central axis of said supporting member;
   a movable member manually actuated for moving the pointer toward a required point on the display at a required speed, said movable member comprising a center shaft enabling to be manually tilted about the sustainer in a tilt direction omni-directionally around the central axis and at a tilt angle from the central axis; and
   a movement converting mechanism provided between said supporting member and said movable member, for converting tilt movement of the center shaft to axial movement performed in an axial direction of the central axis and adding force to said movable member so as to bring the center shaft to the central axis as far as said movable member is freed from manually tilting.

2. A pointing device according to claim 1, wherein said movable member further comprises:

   a round rim perpendicularly projected from the center shaft, encircling the center shaft; and
   a pivot provided to the center shaft so as to be sustained by the sustainer.

3. A pointing device according to claim 2, wherein said supporting member further comprises:

   a base attached to the object and spread perpendicularly from the central axis, having said sustainer on the central axis;
   a cylinder guide for being used with said movement converting mechanism, perpendicularly stood on said base around the central axis; and
   a round housing stood on said base around the central axis, for housing said movement converting mechanism.

4. A pointing device according to claim 3 wherein said movement converting mechanism comprises:

   a slider comprising a cylinder sliding on said cylinder guide and a disk spread perpendicularly from the central axis so as to be in contact with said round rim; and
   a helical spring adding the force to said slider in the axial direction so that said disk is kept in contact with said round rim.

5. A pointing device according to claim 4, wherein said movable member further comprises a pointer positioning element stored in said center shaft, for remotely giving information on the tilt direction and the tilt angle of said center shaft toward the object.

6. A pointing device according to claim 5 further comprising:

   pointer co-ordinate position detectors being at least two in number, provided on the object so as to be separated at equal distance from the central axis respectively, for remotely receiving the information on the tilt direction and the tilt angle of said center shaft from said pointer positioning element and producing signals of the position and the moving speed of the pointer on the display.

7. A pointing device according to claim 4, wherein said supporting member further comprises a wall for defending said movement converting mechanism from dust.

8. A pointing device according to claim 4, wherein the object is a printed circuit board, said pointer positioning element is a permanent magnet, and said pointer co-ordinate position detectors are Hall elements.

9. A pointing device according to claim 1 further comprising:

   a moving mechanism provided beneath said supporting member through the object, for

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changing operation of the pointing device from operation performed under analog pointing system to operation to be performed under digital pointing system vice versa, by turning a part of said moving mechanism; and

a switching unit provided between the object and said moving mechanism, for performing switching operation when said port of said moving mechanism is turned in accordance with the digital pointing system.

10. A pointing device according to claim 9, wherein said moving mechanism comprises:

a stator comprising a center post fixed to the object so as to be placed on the central axis, a plurality of fixed cams provided around said center post;

a rotor fitted to said center post so as to turn around said center post, comprising a plurality of rotating cams provided opposite to said fixed cams respectively, so that said rotor is raised up when said rotating cams run on said fixed cams respectively by turning said rotor in accordance with the digital pointing system; and

a spring provided between the object and said rotor along a surface of said center post, for pushing said rotor toward said stator.

11. A pointing device according to claim 10, said switching unit comprises a plurality of switches raised by said moving mechanism so that one of said switches is turned ON by tilting said movable member when said rotor is turned in accordance with the digital pointing system.

12. A pointing device according to claim 9, wherein said moving mechanism comprises:

a rotor comprising a center post fixed to the object so as to be placed on the central axis, a disk screwed to said center post so that said disk can he rotated around said center post, and a plurality of rotating cams provided on said disk, around said center post;

a stator fitted to said center post through a hole of said stator so as to slide on said center post, comprising a plurality of fixed cams provided opposite to said rotating cams respectively so that said stator is raised when said fixed cams run on said rotating cams respectively by turning said rotor in accordance with the digital pointing system; and

a spring provided between the object and said stator along a surface of said center post, for pushing said stator toward said rotor.

13. A pointing device according to claim 12, wherein said switching unit comprises a plurality of switches raised by said moving mechanism so that one of said switches is turned ON by tilting said movable member when said rotor is turned in accordance with the digital pointing system.

14. A pointing device according to claim 13, wherein said center post of said rotor comprises a straight ditch in a direction of the central axis, and said stator comprises a projection protruded inward the hole so as to be inserted into said straight ditch, for preventing said stator turning together with said rotor.

15. A moving mechanism set on a thing, for moving an article, said moving mechanism comprising:

a rotor comprising a center post set on the thing, a disk screwed to said center post so as to turn around said center post, a plurality of rotating cams provided on said disk so as to be arranged around said center post, and a straight ditch running in a direction the same as a central axis of said center post;

a stator fitted to said center post through a center hole of said stator so as to slide on a surface of said center post, comprising a plurality of fixed cams provided so as to be opposite to said rotating cams respectively so that the article on said stator is moved toward the thing when said rotating cams run on said fixed cams respectively by turning said rotor, and a projection protruded inward the center hole so as to be inserted to said straight ditch, for preventing said stator turning together with said rotor.

Fig. 1

PRIOR ART

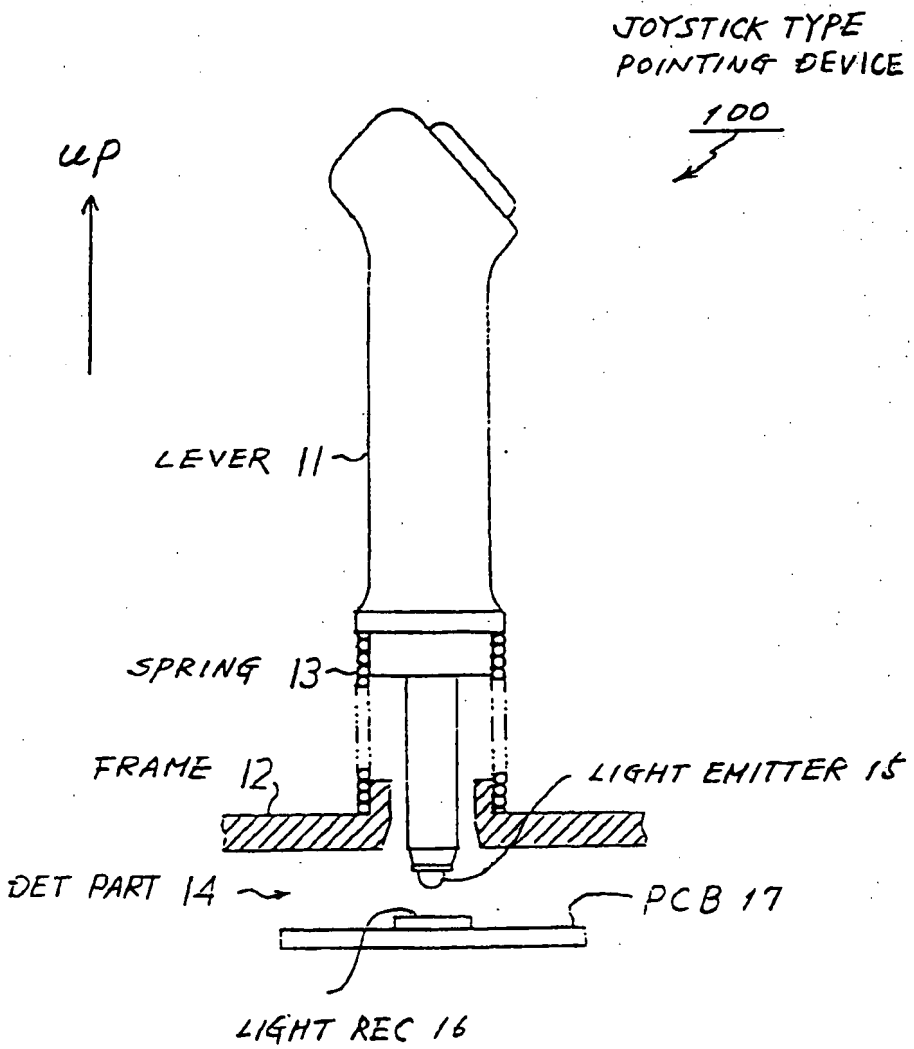
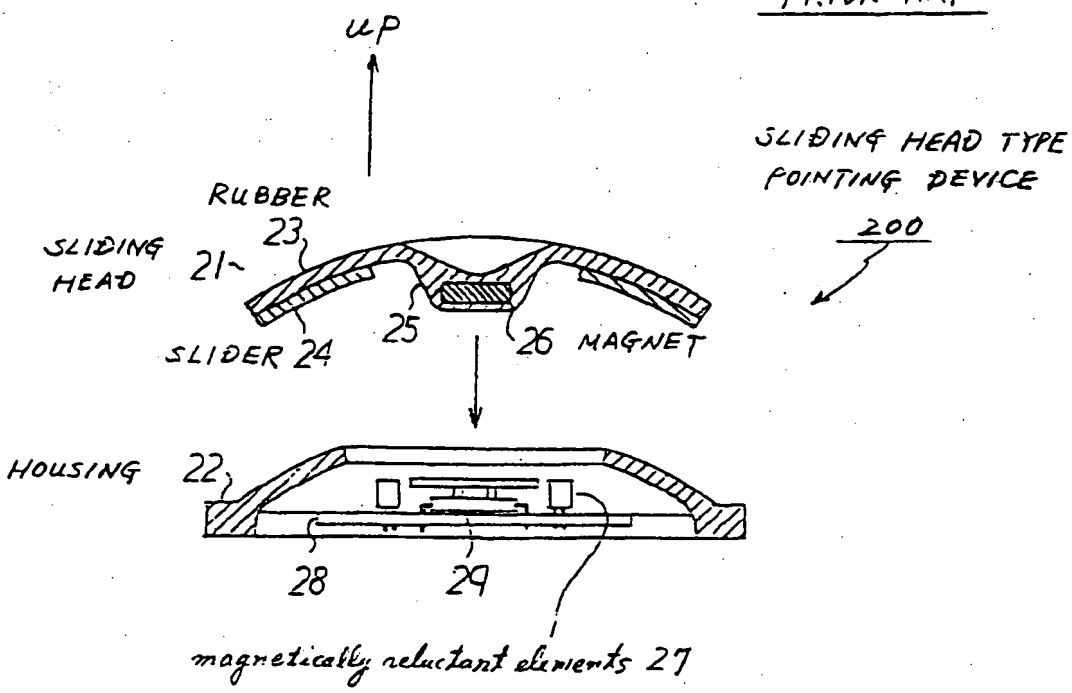


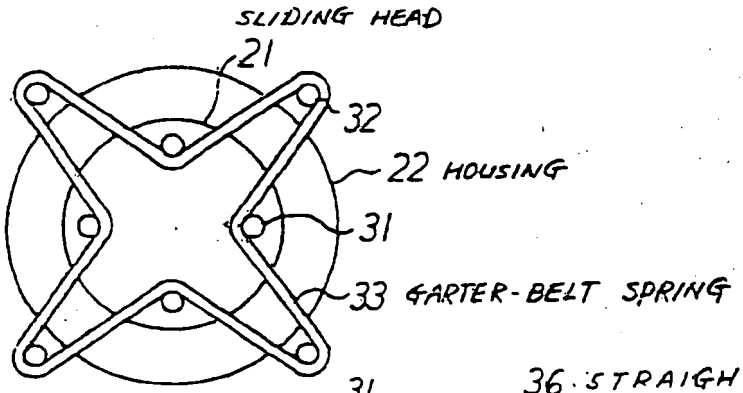
Fig. 2

PRIOR ART



PRIOR ART

Fig. 3A



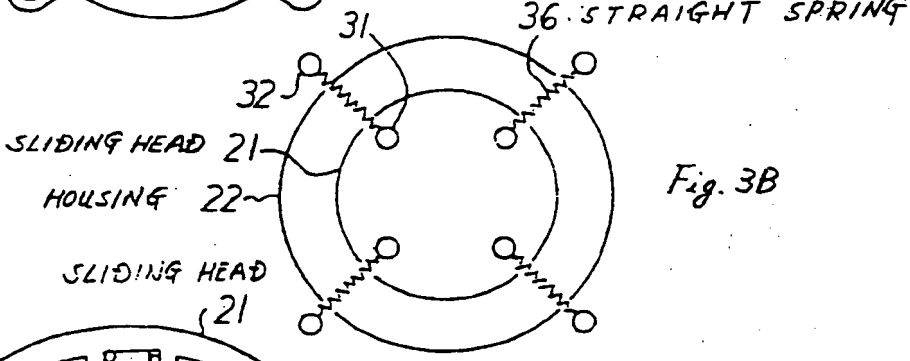


Fig. 3B

Fig. 3C

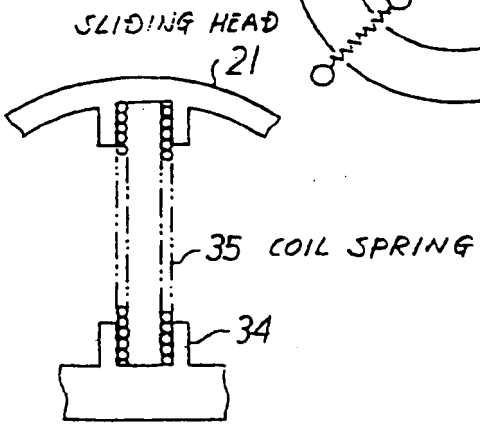


Fig. 4

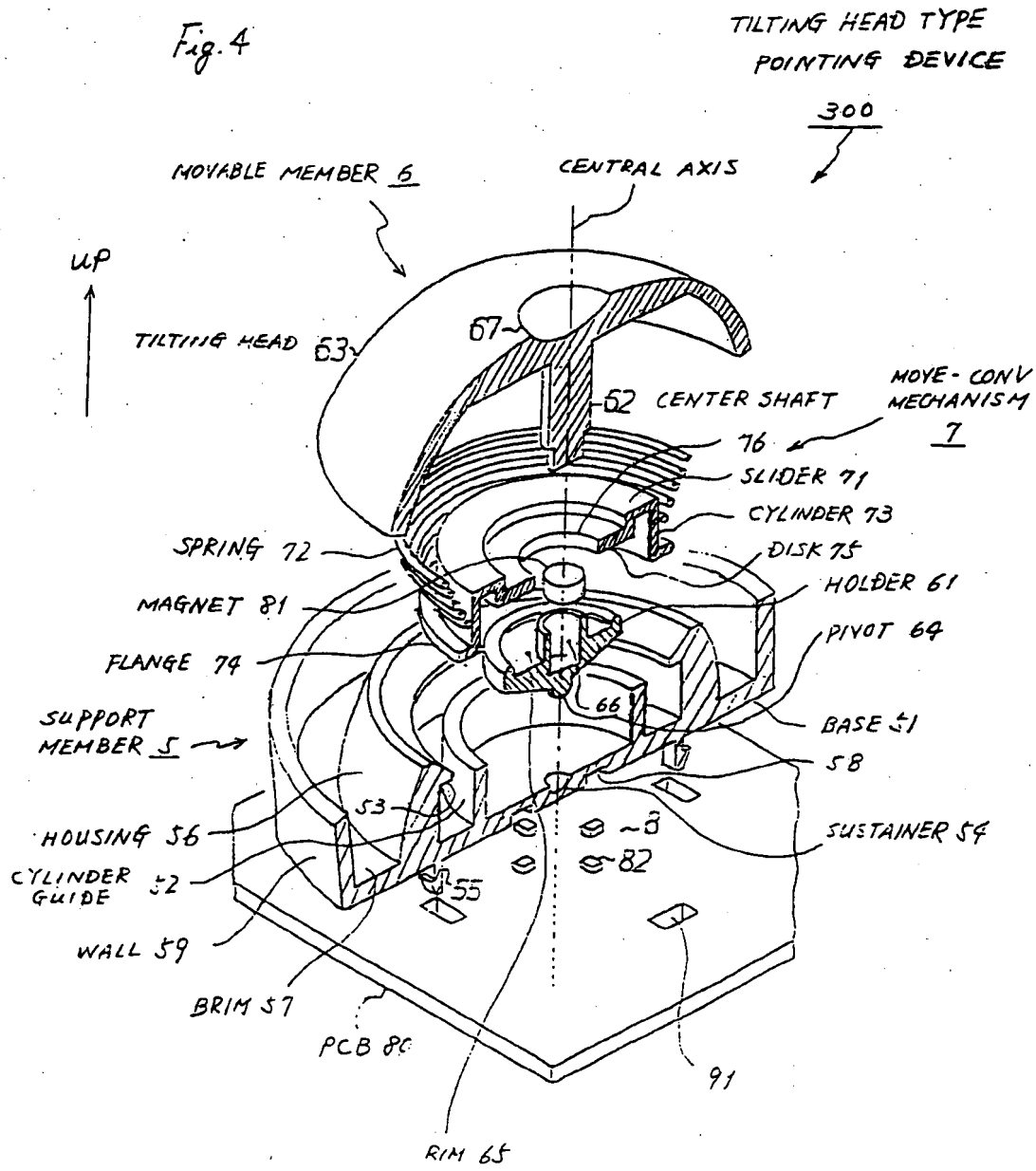


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Fig. 5

TILTING HEAD TYPE POINTING DEVICE

300

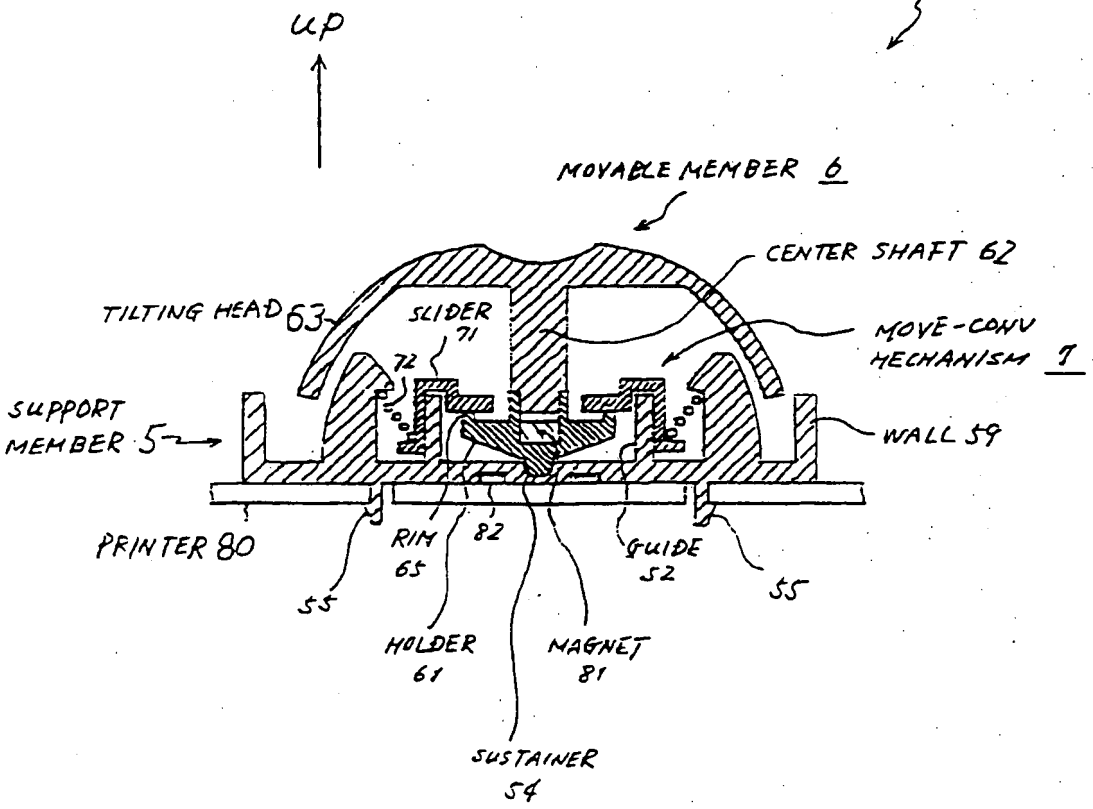

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Fig. 6

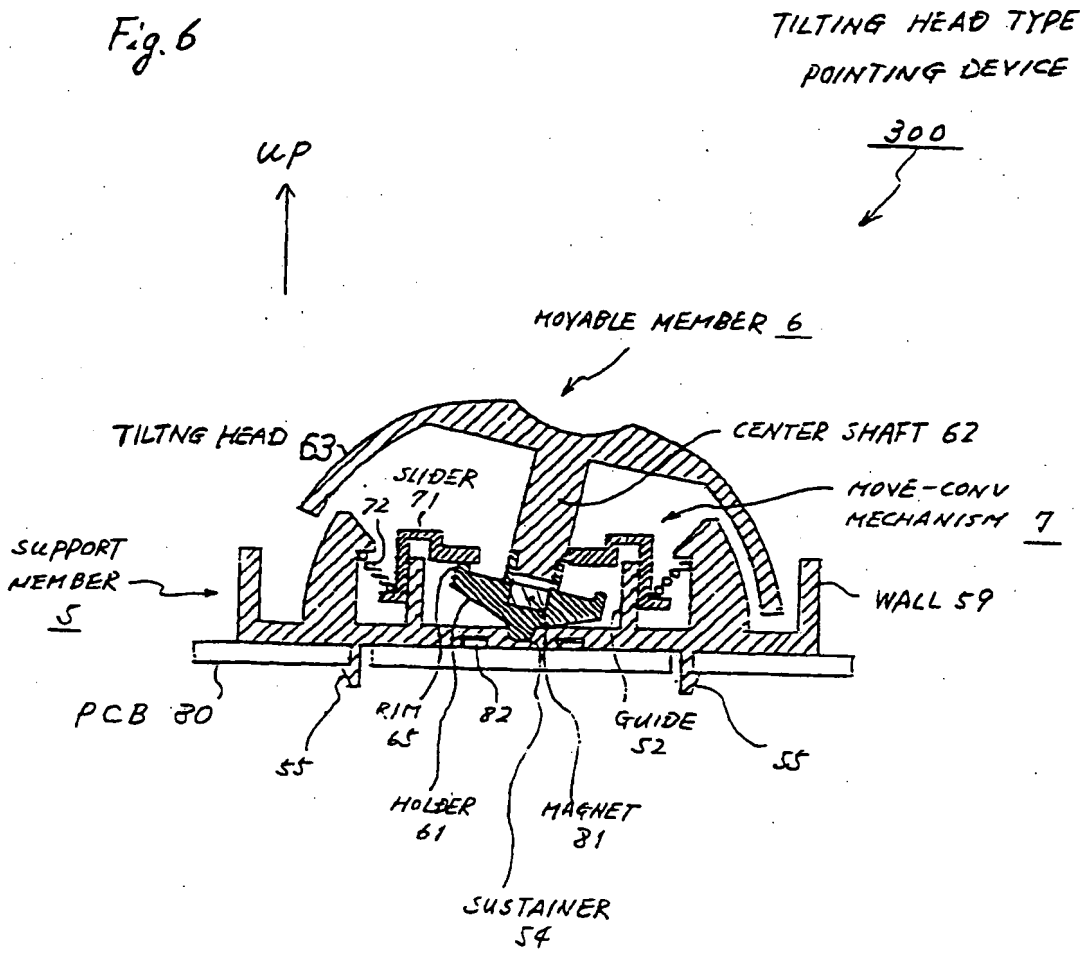
TILTING HEAD TYPE
POINTING DEVICE
300
UP
MOVABLE MEMBER 6
TILTNG HEAD 63
CENTER SHAFT 62
SLIDER
71
72
MOVE-CONV
MECHANISM 7
SUPPORT
MEMBER
5
WALL 59
PCB 80
55
RIM
65
82
GUIDE
52
55
HOLDER
61
MAGNET
81
SUSTAINER
54

Fig. 7

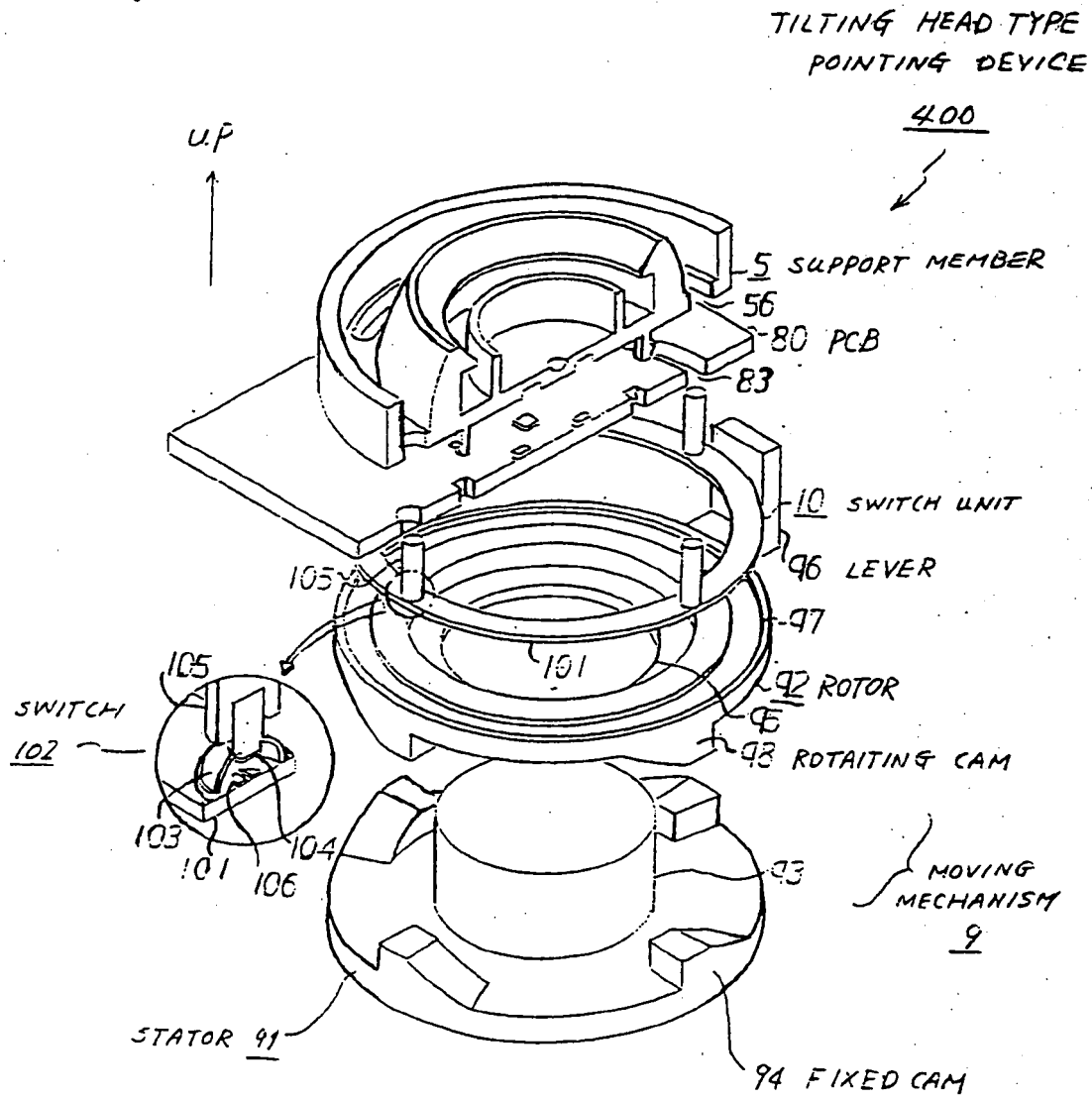

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Fig. 8

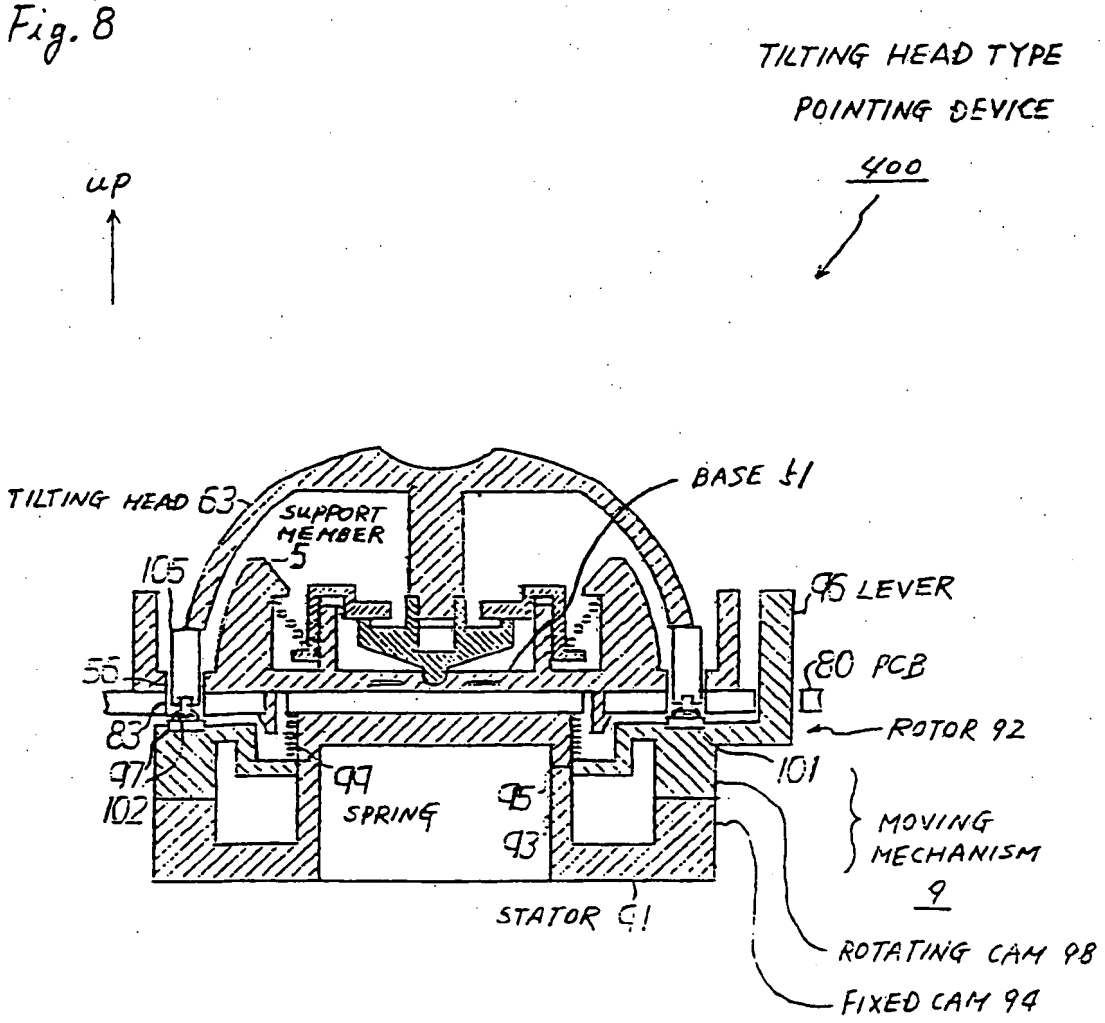


Fig. 9

TILTING HEAD TYPE POINTING DEVICE

400

up

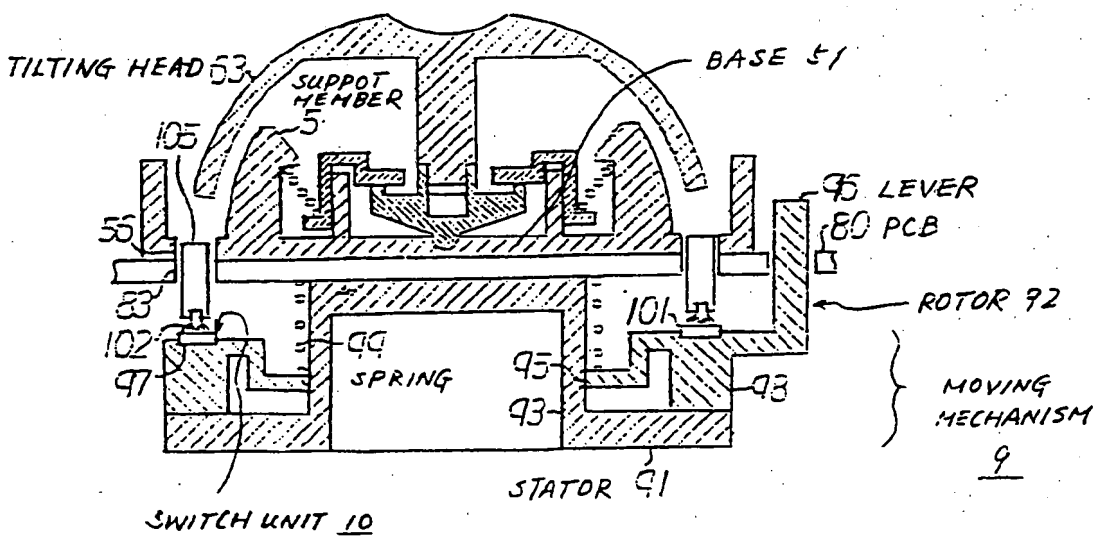
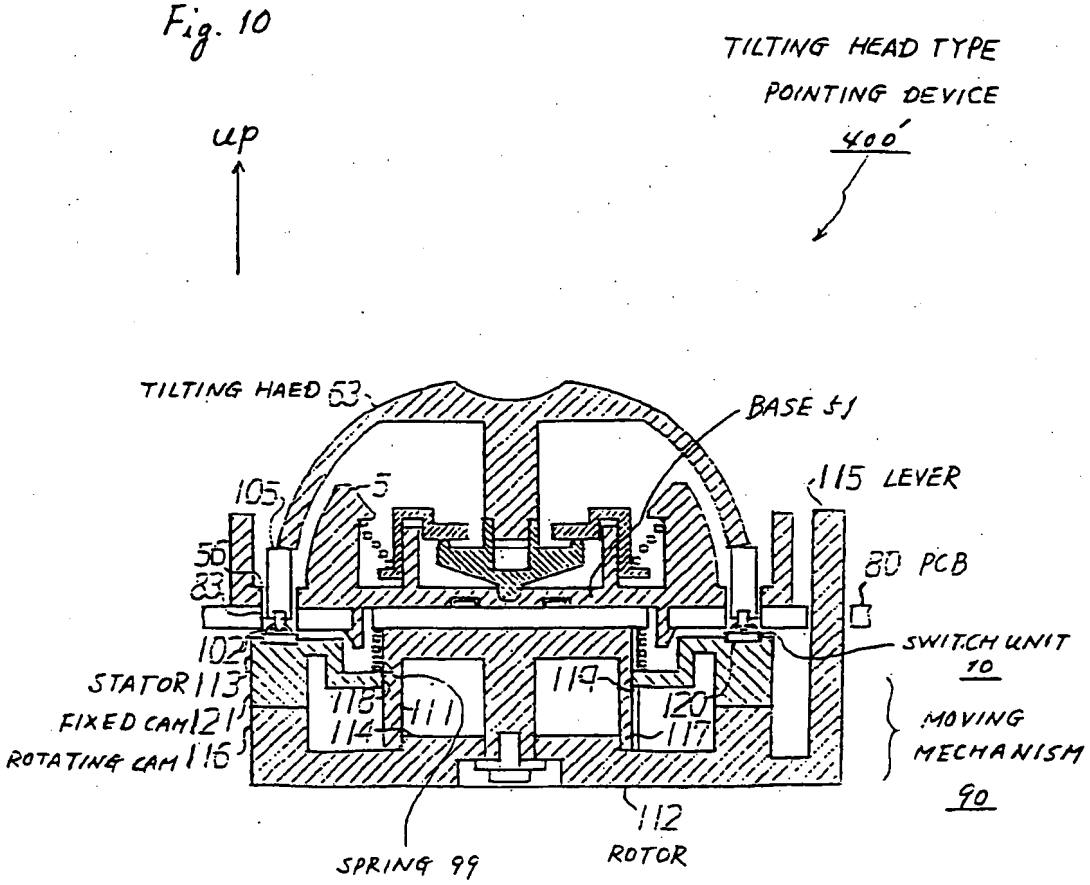


Fig. 10


TILTING HEAD TYPE
POINTING DEVICE
400'
up
TILTING HAED 53
BASE 51
115 LEVER
105
5
50
33
80 PCB
102
SWITCH UNIT
10
STATOR 113
FIXED CAM 121
ROTATING CAM 116
118
114
111
119
120
117
MOVING
MECHANISM
90
112
ROTOR
SPRING 99